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Prognostic value of Prehospital Index (PHI) versus GAP scale measured in hospital emergency room

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ABSTRACT

Introduction: Trauma is one of the major health problems worldwide. There are several indicators for predicting trauma mortality in the world, some of them are physiological, some anatomical, and some others are both psychological and anatomical. Our aim in this study was to compare the predictive power of GAP versus PHI in predicting mortality from trauma. *Methods:* This prospective study was performed using data from Imam Reza Hospital in Tabriz, HaftTir and Sina Hospital, in Tehran, during 2020 and 2021. Descriptive results were reported with mean, standard deviation, absolute frequency and absolute frequency percentage. Simple logistic regression, multiple logistic regression and receiver operating characteristic (ROC) were used to evaluate the predictive power of the studied indices. All analyses were performed at a significance level of 0.05. *Results*: A total of 540 trauma patients participated in this study. The mean and standard deviation of the age of the patients participating in this study was 34.71± 17.65. The majority of the patients (81.67%) were male. Finally, until the 30th day of follow-up, 62 patients (11.48 %) died. Glasgow coma scale (GCS), pulse rate, age, respiratory status and level of consciousness significantly predict trauma mortality (P-value < 0.00). The area under roc curve (AUC) value was 0.926 for PHI and 0.920 for GAP. Conclusion: GAP is a more appropriate index than PHI to predict trauma deaths and triage of trauma patients in the emergency room. We recommend that the use of GAP be prioritized over PHI for triaging patients in the emergency room.

Keywords: prediction, GAP, PHI, scale, trauma

1. INTRODUCTION

Trauma is any type of penetrating or non-penetrating injury or wound that is intentionally or unintentionally caused by external factors (Jalalvandi et al., 2016; Hoyt and Coimbra, 2004).Trauma is one of the major health problems

worldwide. Trauma causes a lot of direct and indirect economic costs (Gioffrè-Florio et al., 2018). There are several scores/scales/models for predicting predictable deaths from trauma (de Munter et al., 2017). Some scores/scales of trauma outcome use only physiological indicators, some use only anatomical indicators, and some use both sets of physiological and anatomical items to predict predictable deaths from trauma (Rahimi Moghar Wafa, 2016). Physiological indicators used in scores predicting trauma deaths vary, some of which include systolic blood pressure (SBP), diastolic blood pressure (D), respiration rate per minute (RR), oxygen saturation (SpO2), pulse rate (PR), level of consciousness and respiratory status. Each of these scores uses a different combination of these indicators (Koehler et al., 1986; Kondo et al., 2011; Ha et al., 2015). Anatomical scores use anatomical variables such as location of injury and severity of injury (Fenner et al., 1971). Physiological scores/scales such as Glasgow coma scale (GCS), GAP (GCS, age, and SBP), MGAP (Mechanism, GCS, age, and SBP) and Pre-hospital Index (PHI) can be mentioned (Koehler et al., 1986; Kondo et al., 2011). Anatomical scores/scales such as the Abbreviated Injury Scale (AIS), the Injury Severity Score (ISS), Modified ISS (ISS) and New Injury Severity Score (NISS) can be mentioned (Fenner et al., 1971; Paffrath et al., 2014; Tohira et al., 2012; Kuo et al., 2017; Salehi et al., 2016). Combined indicators include Trauma Injury Severity Score and Pediatric Trauma Score (St-Louis et al., 2017; de Alencar Domingues et al., 2018).

The pH index consists of the variables of systolic blood pressure (SBP), pulse rate (PR), respiratory status and state of consciousness. PHI was first developed by Koehler et *al*., (1986) PHI is made using pre-hospital data of trauma patients which is used to triage trauma patients and is further developed for use in emergency medical services (EMS). In order to correct the flaws in the MGAP score, the GAP score was first developed by Kondo et al., (2011) GAP consists of GCS, age and SBP. GAP consists of simpler components than many other indices predicting trauma deaths. GAP can be used in patient triage both in the pre-hospital emergency department and in the hospital emergency department to triage trauma patients and identify high-risk patients (Ahun et al., 2014). GAP and PHI are both good indicators for triaging patients, especially in the pre-hospital emergency department, and many studies have recommended the use of these two indicators for triaging trauma patients, especially in the pre-hospital emergency department (Koehler et al., 1986; Ahun et al., 2014; Rahmani et al., 2017). Few studies have been performed on the predictive power of PH index in predicting mortality of trauma patients using hospital data. Also, only few studies have been done to compare the predictive power of GAP with PHI horn in predicting predictable deaths due to trauma. This was done with the aim of determining the prognostic value of the prehospital index (PHI) against the GAP. This study uses data from trauma patients in Imam Reza hospitals in Tabriz, and HaftTir and Sina hospitals in Tehran from 2020 to 2021.

2. METHODS

The sample size for this study was conducted based on parameters from 100 cases as pilot data. To identify at least 0.06 differences in AUC between GAP and PHI with pilot assessed AUC value of at most 0.95 for GAP and standard deviation of 0.2 for GAP and 0.31 for PHI assuming at least 0.95 confidence levels and 0.8 statistical powers. This result a need for 470 samples to which we considered an addition of 15% of the calculated sample for potential attrition. However, as in our plan for assessing the external validity of the modeling, we had considered a test set of 60% and a validation set of 40% of the whole sample for extended research, we have collected data for 540 subjects by now, 540 of whom were used for prognostic value comparison (aimed in present manuscript) and the remainder will be used to assess the estimation robustness of models for various levels of assumed staff measurement error. This study conducted in Imam Reza hospitals in Tabriz and Haft Tir and Sina hospitals in Tehran province. This study was performed prospectively. Participants in this study included trauma patients who were referred to the emergency department of the studied hospitals within 24 hours after the trauma. This study was conducted in 2020 and 2021. Informed consent was obtained from patients to participate in this study; patients could be excluded from the study at any stage of the study. Exclusion criteria for trauma patients in this study are: 1) trauma patients who participated in the emergency department of the studied hospitals due to long-term trauma complications, 2) trauma patients who died on the scene, 3) patients who escaped from the emergency rooms of the studied hospitals after the initial examination and 4) trauma patients who did not consent to participate in this study. Patients' information was collected through a researcher-made questionnaire. The validity of this questionnaire was assessed with content validity index (CVI) and its reliability was assessed using Spearman correlation index. The content validity of the tool was confirmed with a total scale-level content validity (S-CVI) = 0.93. Spearman correlation was above 0.7 for all items. Patients were evaluated by an emergency medicine resident and two general practitioners.

The assessment of the patients in this study was performed in three stages, which were: 1) evaluation in the emergency room of the study hospitals at the time of patient admission, 2) 24 hours after the initial evaluation and 3) 30 days after the initial evaluation. In this study, death was the final point and included death in each of the three stages of patient assessment. In this study, the Prehospital index (PHI) was assessment based on the study of Koehler and her colleagues. PHI index of SBP (>100 mmHg with

0value, 86 to100 mmHg with 1 value, 75 to 85 mmHg with 2 value and 0 to 74 mmHg with 5 value), pulse rate (≥120 with 3 value, 51 to 119 with 0 score and <50 with 5 value), respirations status (normal with 0 value, labored/shallow with 3 value and <10/min/need's intubation with 5 value) and level of consciousness (normal with 0 value, confused/combative with 3 value and no intelligible words with 5 value). The total value for the PHI index is 0 to 20 (0 to 3 value was minor trauma and 4 to 20 major trauma) (Koehler et al., 1986). GAP score in this study was evaluated based on the study of Kondo *et al*., (2011), Gap includes SBP (<60 mmHg with 0 value, 60 to 120 mmHg with 4 score, and> 120 mmHg with 6 value), age (<60 with 3 value and ≥ with 0 value) and GCS (3 to 15 value).

Mean, standard deviation, absolute frequency and absolute frequency percentage were used to report descriptive statistics. The correlation between the variables was examined using Pearson correlation due to the normal distribution of variables (r≥0.8). To investigate and diagnose potential mortality predictors, at first, simple logistic regression was performed using the variables of age, sex, GCS, SBP, DBS, Respiratory status, level of consciousness and PR. Then, multiple regression and odds ratio (OR) were used. Receiver operating characteristic (ROC) parameters were also generated and reported to evaluate the diagnostic values. Also, two models were modeled and evaluated using the studied variables through running multiple regressions. All analyzes were performed at a significance level of 0.05% using STATA version 14.2 statistical software package (Stata Corp LLC, College Station, TX, USA).

3. RESULTS

A total of 540 trauma patients (180 patients from each of the studied hospitals) participated in this study. The mean and standard deviation of the age of patients participating in this study was 34.71± 17.65.441 patients (81.67 %) were male and 99 (18.33 %) were female. Trauma occurred in 462 patients (85.55 %) on non-holidays and in 78 patients (14.45 %) on holidays. 445 patients (82.41 %) were transferred directly from the scene to the emergency department of the studied hospitals and 95 patients (17.59 %) were referred from other government centers. 77 patients (14.26 %) had a history of previous disease and 463 (85.74 %) had no history of any previous illnesses. The most common underlying diseases in patients were: history of surgery / hospitalization or cesarean section (35 patients (6.48 %)), blood pressure (15 patients (2.78 %)), heart disease (12 patients (2.22 %)) and diabetes (15 patients (2.78 %)). It should be noted that some patients had several underlying diseases simultaneously. 83 patients (15.37 %) had a history of smoking, 16 patients (2.96 %) had a history of hookah use, 27 patients (5.00 %) had a history of drug use and 11 patients (2.04 %) had a history of alcohol use. The most common procedure performed on patients in the prehospital phase by the prehospital emergency team was peripheral vein catheterization to protect the infusion (395 patients (73.15 %)). The most common cause of trauma in patients was a motorcycle accident (139 patients (25.75 %)). The most common injuries in patients were head and face injuries (299 patients (55.37 %)), upper limb injuries (203 patients (37.59 %)) and lower limb injuries (197 patients (36.48 %)) (Table 1).

Table 1 Distribution of the cause of trauma and the location of injury in patients.

Part A: Prehospital measures		
Prehospital measures	absolute frequency	Absolute frequency percentage
Airway protection	134	24.81
Infusion protection	395	73.15
Neck protection	277	51.30
Stabilize the pelvis	11	2.04
Limb protection	144	26.67
Spine protection	265	49.07
Coping with hypothermia	84	15.55

Part B: Distribution of cause of trauma		
Cause of trauma	Absolute frequency	Absolute frequency percentage
Pedestrian accident	110	20.37
Bicycle accident	5	0.93
Motorcycle accident	139	25.75
Accident vehicle with three or four wheels	2	0.37
Lightweight car crash	87	16.11
Cargo pickup accident	5	0.93
Heavy vehicle crash	1	0.18
Accident of other vehicles	1	0.18
Fall and slip	90	16.67
Exposure to static/moving mechanical force	14	2.59
Toxic poisoning	1	0.18
Intentional self-harm / suicide	6	1.11
Injury from rape or assault	58	10.74
Unintentional and unintentional incidents	19	3.52
Damage caused by legal interventions	2	0.37
Total	540	100.00

Part C: Location of injury			
Location of injury	Injury status	Absolute frequency	Absolute frequency percentage
Head and face injury	Yes	299	55.37
	No	241	44.63
	Total	540	100.00

Neck injury	Yes	50	9.26
	No	490	90.74
	Total	540	100.00
Thoracic injury	Yes	105	19.44
	No	435	80.56
	Total	540	100.00
Abdominal, pelvic and spine injuries	Yes	91	16.85
	No	449	83.15
	Total	540	100.00
Shoulder and arm injury	Yes	48	8.89
	No	492	91.11
	Total	540	100.00
Elbow and forearm injury	Yes	81	15.00
	No	459	85.00
	Total	540	100.00
Wrist and hand injuries	Yes	74	13.70
	No	466	86.30
	Total	540	100.00
Thigh and hip joint injury	Yes	40	7.41
	No	500	92.59
	Total	540	100.00
Knee and leg injuries	Yes	115	21.29
	No	425	78.71
	Total	540	100.00
Ankle and foot injury	Yes	42	7.78
	No	498	92.22
	Total	540	100.00
Injuries involving different parts of the body	Yes	93	17.22
	No	447	82.78
	Total	540	100.00
Damage to other parts of the trunk and limbs	Yes	20	3.70
	No	520	96.30
	Total	540	100.00
Traces of foreign objects entering through the body's natural holes	Yes	1	0.18
	No	539	99.82
	Total	540	100.00
Burns	Yes	1	0.18
	No	539	99.82
	Total	540	100.00

Until the end of the follow-up period, 62 patients (11.48 %) had died. Out of 62 patients, 18 patients (29.03 %) died in the emergency room, 4 patients (6.45 %) died in 24-hour follow-up and 40 patients (64.52 %) died between 24-hour follow-up and 30-day follow-up. The mean and standard deviation of the age of the deceased patients was 41.13 ± 21.94. Fifty-two patients (83.87 %) were male and 10 patients (16.13 %) were female. The most common causes of trauma among the deceased patients were Light weight car crash (22 patients (35.48 %)), motorcycle accident (19 patients (30.64 %)) and Pedestrian accident (14 patients (22.58 %)).

The most common injuries among deceased patients were head and face injury (55 patients (88.71 %)), thoracic injury (35 patients (56.45 %)), lower limb injuries (26 patients (41.93 %)), upper limb injuries (23 patients (37.09 %)) and abdominal / pelvic / spine injury (22 patients (35.48 %)). Among all patients studied, the mean and standard deviation of GCS, PR, SBP and DBP indices were 12.74± 4.45, 87.36±19.12, 123.58±21.68 and 76.77±14.87, respectively (Table 2).

Table 2 Distribution of SBP, DBP and SpO2 according to sex and age groups

Age group	Sex (N (%)	SBP (SD)	DBP (SD)	GCS (SD)	PR (SD)
> 65	Male (31(73.81))	131.06 (29.84)	81.58 (17.03)	9.84 (5.91)	87.22 (19.48)
	Female (11(26.19))	145.00 (35.92)	82.63 (14.14)	12.91 (4.66)	84.10(8.24)
	Total (42(7.78))	134.71 (31.55)	81.86 (16.16)	10.64 (5.72)	86.46 (17.37)
55-65	Male (35(79.54))	127.14 (26.30)	82.17 (15.61)	11.80 (5.08)	83.71 (13.44)
	Female (9(20.46))	120.33 (12.06)	73.00 (6.61)	15.00 (0.00)	80.00 (4.24)
	Total (44(8.15))	125.75 (24.11)	80.29 (14.66)	12.45 (4.70)	82.95 (12.19)
35-55	Male (113(84.96))	123.72 (22.46)	77.84 (15.62)	12.82 (4.32)	84.00 (18.11)
	Female (20(15.04))	124.30 (14.40)	80.20 (11.62)	13.70 (3.68)	88.80 (16.19)
	Total (133(24.63))	123.80 (21.40)	78.19 (15.07)	12.95 (4.23)	84.76 (17.85)
15-35	Male (244(85.61))	123.53 (19.87)	75.85 (14.70)	13.02 (4.21)	87.41 (19.23)
	Female (41(14.39))	121.17 (17.68)	75.85 (12.20)	13.68 (3.59)	91.00 (19.68)
	Total (285(52.78))	123.18 (19.55)	75.85 (14.35)	13.12 (4.12)	87.94 (19.30)
< 15	Male (23(63.89))	114.21 (15.34)	71.95 (13.07)	11.61 (5.28)	99.45 (28.55)
	Female (13(36.11))	104.69 (12.68)	62.23 (13.20)	11.77 (5.26)	99.00 (25.71)
	Total (36(6.66))	110.78 (14.98)	68.44 (13.77)	11.67 (5.20)	99.27 (27.06)

Abbreviations: SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; GCS: Glasgow coma scale; PR: Pulse rate; SD: Standard Deviation.

In a study of 540 patients, it was found that the gap index was severe in 49 patients (9.07 %). Also, among the total patients, based on the pH index, 119 patients (22.04 %) were in the group of major trauma (Table 3). In logistic regression, it was found that the variables of age, SBP (grouped according to PHI index classification), GCS, pulse rate, level of consciousness and respiratory status were associated significantly with trauma death in the studied patients (Table 4).

Table 3 Distribution of the different PHI and GAP classes

Part A: in total patients		
Score name	groups	Absolute frequency (%)
PHI	Minor group (0-3)	421 (77.96)
	Major group (4-20)	119 (22.04)
	Total	540 (100.00)
GAP	Mild group (19-24)	437 (80.93)
	Moderate group (11-18)	54 (10.00)
	Severe group (0-10)	49 (9.07)
	Total	540 (100.00)
Part B: In deceased patients		
PHI	Minor group (0-3)	6 (9.68)
	Major group (4-20)	56 (90.32)
	Total	62 (100.00)
GAP	Mild group (19-24)	9 (14.52)
	Moderate group (11-18)	16 (25.80)
	Severe group (0-10)	37 (59.68)
	Total	62 (100.00 %)

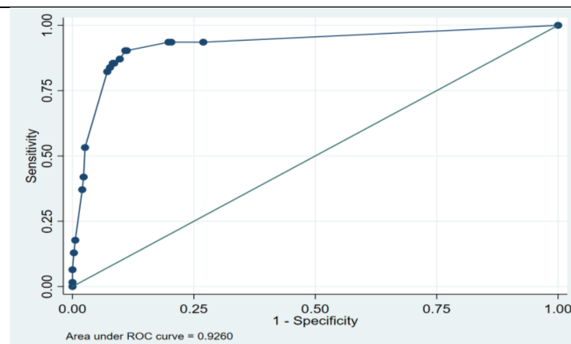
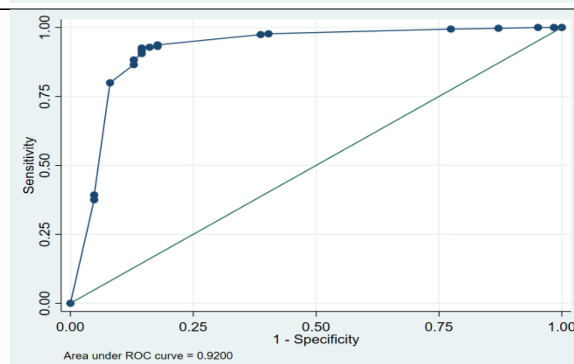
Table 4 Simple regression analysis of variables for prediction of TD

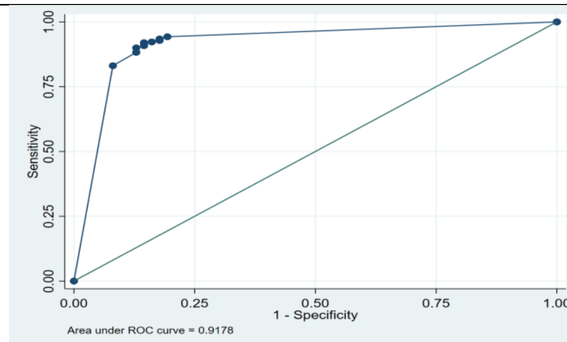
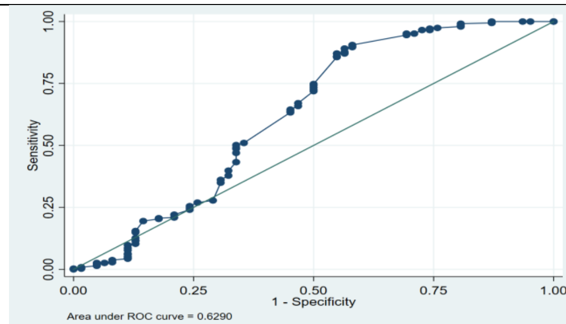
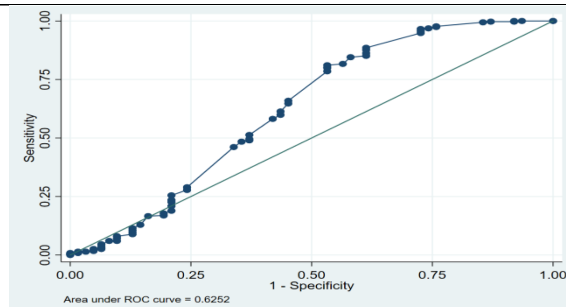
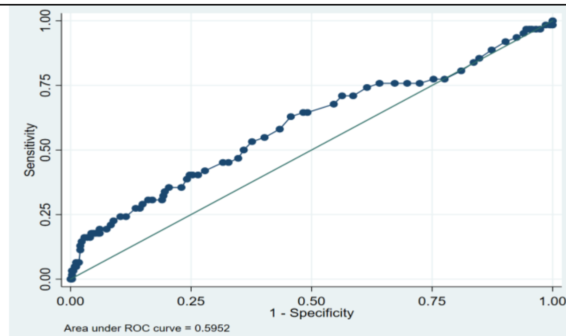
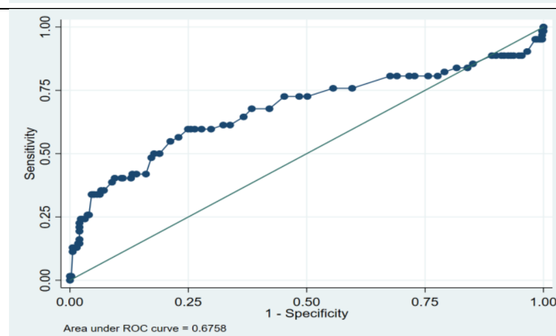
variable	raw OR	β-coefficient (SE)	P-value	95% CI
Sex	0.93	0.225	0.770	0.58-1.49
Age	1.01	0.005	0.002	1.00-1.02
SBP	0.99	0.004	0.373	0.99-1.00
SBP (group in GAP)	0.87	0.075	0.120	0.74-1.03
SBP (group in PHI)	1.85	0.300	0.000	1.34-2.54
DBS	0.99	0.006	0.287	0.98-1.00
GCS	0.84	0.018	0.000	0.80-0.88
PR	1.01	0.005	0.000	1.01-1.02
respirations status	1.38	0.066	0.000	1.25-1.51
level of consciousness	1.44	0.070	0.000	1.31-1.59

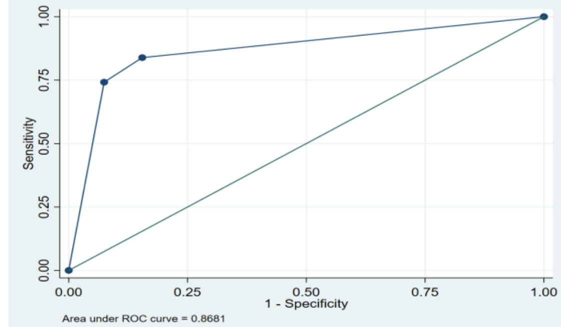
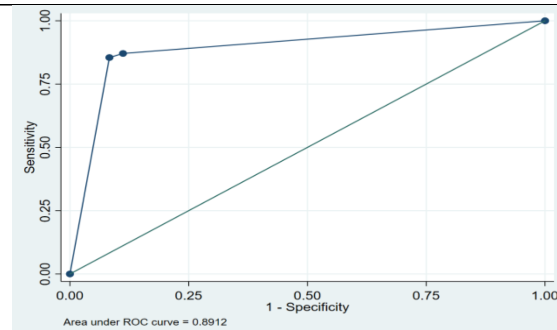
Abbreviations: CI: Confidence Interval, TD: trauma death

Both PHI (AUC= 0.926) and GAP (AUC= 0.920) had good diagnostic power for predicting predictable trauma mortality. The diagnostic power of the PHI index is slightly higher than that of the GAPscore. The GSC score alone is a high-strength index (AUC= 0.917) for predicting predictable deaths from trauma (Table 5).

Table 5 Diagnostic values of the parameters and scales for prediction of TD.

Parameter	AUC	95% CI	ROC
PHI	0.926	0.88-0.96	
GAP	0.920	0.87-0.96	

GCS	0.917	0.87-0.95	
SBP	0.629	0.53-0.72	
DBP	0.625	0.53-0.71	
Age	0.595	0.51-0.67	
PR	0.675	0.59-0.76	

respirations status	0.868	0.81-0.92	
level of consciousness	0.891	0.84-0.93	

Abbreviation: AUC: Area under ROC curve, CI: confidence interval, ROC: Receiver operating characteristic

The PR alone was not a good indicator for predicting predictable deaths due to trauma, but when placed in the PHI index it has a high diagnostic value. The SBP alone was not a good indicator for predicting predictable deaths due to trauma, but when placed in the PHI index or GAP score it has a high diagnostic value. Modeling also showed that GAP and PHI significantly predict predictable deaths due to trauma (Table 6).

Table 6 Multiple binary logistic regression analysis models for predicting TD

Model name	Model components	Values	OR	P-value	95% CI
Model 1	GCS	3-15	0.81	0.167	0.60-1.09
	Age	<60 years	0.42	0.006	0.22-0.77
		≥60 years			
	SBP	≤60 mm Hg			
		60 to 120 mm Hg	1.15	0.517	0.75-1.78
		>120 mm Hg			
	SBP	>100 mmHg			
		86 to100 mmHg	1.25	0.536	0.61-2.58
		75 to 85 mmHg	2.32	0.249	0.55-9.70
		0 to 74 mmHg	3.25	0.317	0.32-32.69
	PR	≥120	2.27	0.033	1.07-4.81
		51 to 119			
		<50	3.37	0.377	0.22-50.09
	respirations status	normal			
		labored/shallow with	0.62	0.268	0.27-1.44
		10/min/need's intubation	1.26	0.762	0.27-5.85
	level of consciousness	normal			
		confused/combative	0.83	0.807	0.50-3.51
		no intelligible words	0.32	0.448	0.01-6.05
Model 2	GAP	(19-24) Mild group			
		(11-18) Moderate group	0.90	0.845	0.31-2.56

		(0-10) Severe group	4.08	0.021	1.23-13.43
	PHI	Minor group			
		Major group	3.74	0.006	1.46-9.60

4. DISCUSSION

The mean (standard deviation) of the age of the patients participating in this study was 34.71 ± 17.65. In this study, 52.78% of the patients were in the age group of 15-35 years old. In a study conducted by Jamalian et al., (2020) the mean and standard deviation of the age of patients were 44.03 ± 22.43. Yousefzadeh Chabak and Razzaghi (2019) reported the mean and standard deviation of patients' age to be 34.25 ± 19.07. In 2016, a study of 78807 trauma patients, Moore et al., (2017) reported that the highest number of patients was in the age group of 16-54 years (44773 (56.80%). In a study conducted by Saatian et al., (2017), the mean and standard deviation of the age of trauma patients was 29.70 ± 21.46. Omid Gerkez and colleagues (2018) in a study conducted in 2016 on 760 patients got injured in road accidents, mentioned that most of the injured were men and women in the age group of 15-54 years. In a study of 372 trauma patients, Manwana and colleagues (2018) reported that the median age of their patients was 33.50 years. All of these studies were consistent with our study and show that most cases of trauma occur in young age groups.

In our study, it was found that although the age variable can significantly predict predictable deaths due to trauma, it does not have a good predictive power. Since most cases of trauma and deaths due to trauma occur in young age groups, age B alone cannot be a very good variable to predict deaths because of trauma. Therefore, we recommend that the age variable be used in combination with other predictors of trauma mortality. The study found that most cases of trauma occur in men. It was, also, found that gender does not have good predictive power to predict death from trauma. Other studies have reported that about 70% of trauma cases occur in men (Jamalian et al., 2020; Ghaderi Mohammad, 2019; Taravatmanesh et al., 2015; Hosseinzadeh, 2017). These findings are consistent with the results of our study. This suggests that gender is not a suitable variable to predict death from trauma. In our study, it was found that the SBP variable alone could not be a good variable for predicting death from trauma. But this variable can be used in combination with other indicators.

In our study, it was found that the predictive power of PHI index (0.926) is slightly higher than that of GAP score (AUC= 0.920). Other studies that have been performed on the GAP score to predict trauma mortality have also reported values similar to those found in our study. The AUC value for GAP score is reported to be 0.910 in one study and 0.872 in another study (Mahnaz Yadollahi, 2020; Hasler et al., 2014). These studies along with our study show that the GAP score has a high power in diagnosing mortality caused by trauma. In our study, the AUC for the PHI index was 0.926. In a study conducted by Ruan et al., (2018), the aim was to compare the predictive power of the PHI index with the ISS score to predict death from trauma in trauma patients. The AUC value for PHI index was 0.871 (confidence range of 0.95% equal to 0.855-0.886).The predictive power of the PHI index in predicting trauma mortality is as high as the GAP score. The advantage of GAP score over PHI Index is the simplicity of calculating and evaluating GAP over PHI. The GAP consists of three components (Kondo et al., 2011), but the PHI consists of four components. Therefore, it is easier to evaluate the GAP index than the PHI. Another advantage of the GAP over the PHI is the presence of GCS in the GAP.

In the PHI, the level of consciousness is classified into three forms, which are normal, confused/combative and no intelligible words (Koehler et al., 1986). If the level of consciousness in the GAP is assessed using GCS (Kondo et al., 2011). GCS alone is a good indicator of predicting trauma deaths (Saika et al., 2015). One other advantage of GAP over PHI is the way these indicators are categorized. The GAP divides patients into three categories (minor group, moderate group, and severe group) in terms of risk of death (Kondo et al., 2011), but the PHI index divides patients into only two groups in terms of risk of death (minor trauma and major trauma) (Koehler et al., 1986). The simplicity of assessing the GAP allows service staff in the emergency room to calculate the GAP more quickly. Therefore, by using the Gap index, treatment personnel can operate in the emergency room with higher speed and accuracy to identify trauma patients with a higher risk of death.

5. CONCLUSION

The predictive power of the GAP for trauma deaths is not much different from that of PHI. The GAP is made up of fewer components and thus is easier to calculate. GAP assessment is less dependent on the quality of the assessor than PHI assessment. Therefore, the possibility of error in the evaluation of the gap is less than the PHI. Also, the GAP index has the GCS index, which alone is a good predictor of trauma mortality, while the GCS is not present in the PHI. As the GAP assessment is easier than PHI; the possibility of error is much less likely in the GAP assessment to predict mortality due to trauma in the emergency room, the

GAP is more appropriate than the PHI and can be used more easily. Therefore, we recommend that in the emergency room of hospitals, the GAP be used first to predict death due to trauma.

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Author Contributions

All authors of this study were equally involved in the design of the study, data collection, analysis, drafting and correction of the final draft, and the author was responsible for the proper implementation of the study at all stages. There is no author whose name is not listed in the authors list.

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Ethical issues

This study is an excerpt from a master's thesis and is part of a national study. Ethics Code number for national level study was IR.TBZMED.REC.1396.999 and the master thesis project in field of Epidemiology was included under the approval number of 61281.

Conflict of Interest

The authors declare that there are no conflicts of interests.

Data and materials availability

All data associated with this study are present in the paper.

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